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Financial reporting of price-level changes: the index number problem, Appendix A

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APPENDIX A

FINANCIAL REPORTING OF PRICE-LEVEL CHANGES

THE INDEX NUMBER PROBLEM

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PREFACE

This Appendix on the index number problem is being circulated as a separate document at the present time because it differs in nature from the material contained in four other technical appendixes to the price-level research project that are also being circulated at this time:

Appendix B - Disclosing Effects of Price-Level Changes

Appendix C - Demonstration of the Adjustment Technique

Appendix D - Gains and Losses Attributable to the Holding of Monetary Items When Prices Change

Appendix E - Annotated Bibliography

These four appendixes (B through E) are available in multilith as a single document. One copy may be obtained free of charge by a member of the American Institute of Certified Public Accountants on request.

This appendix was prepared by Cecilia V. Tierney of the staff of the accounting research division. Professor Dorothy Brady of the University of Pennsylvania reviewed this material for the soundness of the statistical concepts employed, especially with regard to Chapter 3, "The criteria of adequate price indexes." We are grateful to her for her assistance but hold her blameless for any flaws the report still may have.

Maurice Moonitz
Director of Accounting Research

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CHAPTER 1

INTRODUCTION

The Purpose of the Study

The purpose of this study is to give accountants an outline of some of the problems involved in index number construction and their implications for accounting records and statements. This involves (1) a review of the criteria of a satisfactory price index, with special reference to one that will measure the general level of prices, (2) an examination of some of the well-known price indexes that are currently compiled to see how well they meet these criteria, and (3) the selection of the index (of those studied) that best measures changes in the general level of prices, including an indication of its limitations and suggestions for improvement.

Some Applications of Index Numbers

Some familiar indexes -- The use of index numbers to express the relationship between existing conditions and some norm (base condition) is familiar to all. The changes in the "cost-of-living" are commonly expressed in terms of the U. S. Bureau of Labor Statistics' (BLS) Consumers Price Index popularly known as the cost-of-living index. The public has been introduced to the U. S. Department of Agriculture's Parity Index in discussions of agricultural price supports, while increases or decreases in industrial activity are expressed in terms of the Index of Industrial Production published by the Federal Reserve Board.

Early adjustments for fluctuations in the value of money--Adjustment for fluctuations in the value of money is not new. Irving Fisher in The Money Illusion gives many examples of cases both here and abroad of contracts that provided for payment of money equal in value to a specified amount of a commodity or group of commodities.[1] One of his examples refers to a law passed in Massachusetts in 1780 providing for the payment of certain notes issued by the State in money equal to the value of a group of commodities. The note specified:

> Both Principal and Interest to be paid in the then current Money of said State, in a greater or less Sum, according as Five Bushels of Corn, Sixty-eight Pounds and four-seventh Parts of a Pound of Beef, Ten Pounds of Sheeps Wool, and Sixteen Pounds of Sole Leather shall then cost, more or less than One Hundred and Thirty Pounds current Money, at the then current prices of the said Articles.[2]

Labor has used an index of the "cost-of-living" as a lever for raising wages during inflation since prior to the entry of the United States into World War I. Beginning in 1922, subsistence and rent allowances for all commissioned officers in the armed services were determined by changes in the cost-of-living figures of the United States Bureau of Labor Statistics.[3]

1/ (Adelphi Company, 1928), pp. 114-22.

2/ Ibid., p. 118.

3/ Ibid., pp. 119-21.

An Index and a Price Index Defined

What an index is--Ratios are measures of the size of one quantity relative to the size of another. A ratio may be expressed either as a fraction, e.g., 5/4, or as the quotient derived by dividing the numerator of the fraction by the denominator, e.g., 5/4 = 1.25. A ratio multiplied by 100 becomes a percentage, i.e., 1.25 x 100 = 125%. In other words, 5 is 125% of 4. When each term in a series of quantities is compared to a given term and the ratios are converted to percentages, the percentages are called relatives or index numbers and the series of percentages is called an index. Therefore, an index can be defined as a succession of measurements, expressed as percentages, of the size of each term in a series of quantities relative to a given term. The individual measurements that make up the series are index numbers.

What a price index is--There are many currently compiled indexes that measure changes in prices of particular commodities or groups of commodities, for particular industries or group of industries, for various segments of the economy and for the economy as a whole. The classes of indexes that measure changes in prices are called price indexes. This group of indexes is of particular interest for accounting applications.

Price indexes may be divided for convenience into two types: (1) those that measure relative changes in the prices of specific commodities or related groups of commodities, and (2) those that measure relative changes in the price level prevailing in the economy as a whole or in a segment of that economy. These two types

differ in the scope of the prices measured. A third group, those that measure the change in the purchasing power of the dollar either in the economy as a whole or in a segment of it, are the reciprocals of the price-level indexes and are not, strictly speaking, "price indexes." They measure the changes in the exchange value of money rather than in prices, whereas the price-level indexes measure changes in the quantity of goods and services that money will buy. For example, if the general level of prices in 1962 is at 150[4/] (1952 = 100), then prices are 150/100 or 3/2 as high in 1962 as in 1952. The purchasing power of the dollar in 1962, however, is the "reciprocal" of 3/2, or 2/3, or 66-2/3% of its power in 1952.

4/ The per cent sign (%) is understood but not expressed with index numbers.

A price index can be defined for purposes of this study as a series of measurements, expressed as percentages, of the relationship between the average price of a group of goods and services at a succession of dates[5/] and the average price of a similar group of goods and services at a common date. The components of the series are price index numbers. A price index does not, however, measure the movement of the individual component prices, some of which move in one direction and some in the opposite direction.

5/ Price indexes may compare prices in different places as well as at different times but comparisons between places are not within the scope of this study.

Weighting an index-- An index of the price level compares the relative changes in the prices of all goods and services

exchanged in the economy. Since more than one commodity is involved, it is necessary to give consideration to the relative importance of each one. This is termed "weighting." To illustrate the importance of "weighting," the following familiar example from the area of financial statement analysis is presented. It is the case of the relationship among gross profit per unit, number of units sold, and the rate of gross profit for the business as a whole:

	Period I		Period II	
Commodity A				
Sales price	$100	100%	$110	100%
Cost	60	60	62	56
Gross profit	$ 40	40%	$ 48	44%
Sales in units	9,000		4,000	
Commodity B				
Sales price	$ 50	100%	$ 60	100%
Cost	40	80	45	75
Gross profit	$ 10	20%	$ 15	25%
Sales in units	1,000		10,000	
	10,000		14,000	

Between Period I and Period II, the sales price per unit increased by $10 for both Commodity A and Commodity B. The gross profit on a unit of Commodity A increased from 40 to 44% of the selling price, or $8 a unit. The gross profit on a unit of Commodity B also increased; in this case from 20 to 25% of the selling price, or $5 a unit. In addition, the total units of product sold increased from 10,000 units in Period I to 14,000 units in Period II. But note the effect on the rate of gross profit of the business when there is a shift in quantities between high profit and low profit commodities:

	I			II		
Sales						
A: 9,000 @ 100	$900,000			4,000 @ 110	$440,000	
B: 1,000 @ 50	50,000	$950,000	100%	10,000 @ 60	600,000	$1,040,000	100%
Cost						
A: 9,000 @ 60	$540,000			4,000 @ 62	$ 248,000	
B: 1,000 @ 40	40,000	580,000	61	10,000 @ 45	450,000	698,000	67
Gross profit		$370,000	39%			$ 342,000	33%

The effect of the shift in importance of the number of units sold from a high profit commodity (A) to a low profit commodity (B) is shown in the reduced rate of gross profit for the two commodities combined. The favorable effects of an increase in gross profit per unit for both A and B are more than offset when the unit profits are "weighted" by the quantities sold.

The base date-- The common date that serves as the basis of comparison in an index is referred to as the base, base date, or base period. The base date may be either a point in time (e.g., June 12, 1960) or it may be a period of some duration (e.g., 1954 or 1947-49). The indexes currently compiled by the federal government use a period of either a year or three years as a base.

In a price-level index, a base date that covers one or more years is desirable because of the seasonal character of so many important commodities. If the duration of the base is only a day, or even a month or a quarter, it may not be possible to get representative prices for commodities that are out of season. When the base date is one or more years, the prices for the base are the average prices over that time.

It is not necessary for the base date to be considered "normal," although this may be desirable for some types of analysis. Any date may serve as the base date as long as the commodities being compared at the respective dates have enough in common for the comparison to be valid.

Example of the Construction of a Simple Price Index for Lifo Inventory Valuation

The dollar-value method of pricing Lifo inventories under the Internal Revenue Code presents an interesting example of the construction by the accountant of a relatively simple price index, and the application of that index to the solution of an accounting valuation problem. The following example, taken from T.D. 6539, §1.472-8 (Jan. 20, 1961),[6/] illustrates the computation of the Lifo value of inventories under the "double-extension" rule.

6/ Also Reg. §1.472-8(e)(2)(v), Income Tax Regulations as of February 1, 1961. CCH 1961, 051-6,7.

(*a*) A taxpayer elects, beginning with the calendar year 1961, to compute his inventories by use of the LIFO inventory method under section 472 and further elects to use the dollar-value method in pricing such inventories as provided in paragraph (a) of this section. He creates Pool No. 1 for items A, B, and C. The composition of the inventory for Pool No. 1 at the base date, January 1, 1961, is as follows:

Items	Units	Unit cost	Total cost
A	1,000	$5.00	$5,000
B	2,000	4.00	8,000
C	500	2.00	1,000
Total base-year cost at Jan. 1, 1961			14,000

(*b*) The closing inventory of Pool No. 1 at December 31, 1961, contains 3,000 units of A, 1,000 units of B, and 500 units of C. The taxpayer computes the current-year cost of the items making up the pool by reference to the actual cost of goods most recently purchased. The most recent purchases of items A, B, and C are as follows:

Item	Purchase date	Quantity purchased	Unit cost
A	Dec. 15, 1961	3,500	$6.00
B	Dec. 10, 1961	2,000	5.00
C	Nov. 1, 1961	500	2.50

(*c*) The inventory of Pool No. 1 at December 31, 1961, shown at base-year and current-year cost is as follows:

Item	Quantity	Dec. 31, 1961, inventory at Jan. 1, 1961 base-year cost		Dec. 31, 1961, inventory at current-year cost	
		Unit cost	Amount	Unit cost	Amount
A	3,000	$5.00	$15,000	$6.00	$18,000
B	1,000	4.00	4,000	5.00	5,000
C	500	2.00	1,000	2.50	1,250
Total			20,000		24,250

(*d*) If the amount of the December 31, 1961 inventory at base-year cost were equal to, or less than, the base-year cost of $14,000 at January 1, 1961, such amount would be the closing LIFO inventory at December 31, 1961. However, since the base-year cost of the closing LIFO inventory at December 31, 1961, amounts to $20,000, and is in excess of the $14,000 base-year cost of the opening inventory for that year, there is a $6,000 increment in Pool No. 1 during the year. This increment must be valued at current-year cost, i.e., the ratio of 24,250/20,000, or 121.25 percent. The LIFO value of the inventory at December 31, 1961, is $21,275, computed as follows:

Pool No. 1

	Dec. 31, 1961, inventory at Jan. 1, 1961, base-year cost	Ratio of total current-year cost to total base-year cost*	Dec. 31, 1961, inventory at LIFO value
		Percent	
Jan. 1, 1961, base cost	14,000	100.00	$14,000
Dec. 31, 1961, increment	6,000	121.25	7,275
Total	20,000		21,275

* The index numbers.

In this case, an index number is used to value the increase in the inventory pool at current-year cost. The entire ending inventory is priced at both base year and current year cost and the relationship between the two is expressed as an index number. The increment in the inventory pool, expressed in base year costs, is multiplied by this index number to convert it to current cost.

The weighted average used for the computation of this index is known as "Paasche's formula" which may be expressed as $\frac{\sum p_1 q_1}{\sum p_0 q_1}$ where the subscript "1" (one) refers to the current year and the subscript "o" to the base year.7/ Applied to the example above, this expression reads:

> To find the index number for the current year
>
> divide (i) the sum (Σ) of the actual units included in the ending inventory (q_1) expressed in current year prices (p_1)
>
> by (ii) the sum (Σ) of the same items (q_1) expressed in base year prices (p_0).
>
> To complete the process, multiply the resulting ratio by one hundred.

Federal Income Tax Regulations also permits the accountant to use any index that is acceptable to the Commissioner.8/

7/ This and other formulas are discussed at greater length in Chapter 3.

8/ United States Bureau of Labor Statistics' (BLS) indexes which are applicable to the goods in question are acceptable to the Commissioner. Reg. §1.472-1(k), Income Tax Regulations as of February 1, 1961. CCH. 1961, p. 31049.

Conversion Technique

Index numbers are used to convert an amount from one point of time to another. The procedure used is to multiply the amount involved by the index number of the point in time to which the conversion is to be made, I_1, and to divide by the index number of the point of time from which the conversion is made, I_o. Expressed as a fraction, this procedure becomes $\frac{I_1}{I_o}$. For example, to convert a cost of $36,000 from a point of time when the relevant index stood at 90 (I_o) to a point of time when it stood at 120 (I_1), multiply $36,000 by $\frac{120}{90}$.

$$\$36,000 \times \frac{120}{90} = \$48,000.$$

The same process could be used to convert the $48,000 from the later date to the earlier date, specifically $\$48,000 \times \frac{90}{120} = \$36,000$, which is the original amount.

Relationship of an Index to Its Intended Use

If an index (or indexes)is to be used in the preparation of financial reports, the type of information that accounting statements should convey must be clearly defined because the desired result determines the data from which the index is constructed. If, for example, the statements are to reflect the situation as to physical capital maintenance, a set of indexes that measure the specific price changes that affect the individual accounts would be appropriate. If, however, "capital maintenance" refers to the general purchasing power of enterprise capital, an index of the general level of prices is called for.

When relative weights are held constant, changes in an index are caused by changes in the relative prices of the specific commodities priced. Therefore, an index cannot measure directly price changes for either a smaller or larger group than the group it represents: an index of prices paid by farmers does not measure changes in prices paid by city dwellers, nor does it measure the average price change in the economy as a whole, since prices do not react in the same way in all segments of the economy. In this sense, there is a cause and effect relationship between the data from which an index is constructed, and the movement of terms in that index.

For example, suppose an index of the general level of prices is desired but the only one available is an index that applies to only a limited segment of the economy. Even though the desired index and the substitute both refer to "price levels," the results would not necessarily be comparable because the indexes are measures of different things.

There may, however, be a high degree of correlation between two indexes so that the price movements measured by an index for one segment of the economy may approximate price movements in another sector or in the economy as a whole. When this correlation exists, the index for one segment of the economy may be used to estimate relative price changes in the other sector, or in the economy as a whole, when the desired index is not available. It must be remembered, however, that there is no

guarantee that this relationship will continue. Unless there is something inherent in the data from which the indexes are constructed that will insure the permanence of parallel tendencies, the possibility of dissociation, with its accompanying effect on financial reporting, should be recognized whenever a substitute index is used.

In recent decades the Consumer Price Index, the GNP (Gross National Product) Implicit Price Deflator, and the Composite Construction Cost Index have usually "moved together" (the direction of change and the turning points, but not the amplitude). The kind of reason that may explain these parallel tendencies might be found in the importance of wages and salaries in the economy. One possible explanation, for example, is that labor costs account for a high proportion of Gross National Product while the Consumer Price Index and the Composite Construction Cost Index cover commodities with a high content of labor cost; therefore all three indexes are greatly influenced, directly or indirectly, by movements in wages and salaries. Some correlation is therefore to be expected — a high correlation is not surprising.

The purpose for which an index is intended determines the data to be compared. An index of price changes in one specific market of one specific commodity will be constructed from prices of that commodity in that market. An index of the average price change of a group of commodities in one market will be constructed from suitably weighted prices of those commodities in that market. An index of the relative change in the over-all level of prices can only be constructed from data that are representative of all goods and services exchanged in all segments of the economy.

CHAPTER 2

CURRENTLY AVAILABLE PRICE INDEXES

A BRIEF DESCRIPTION

Types of General Price Information That Are Available

The wealth of data that have been published in this country from an early date gives evidence that "a strong passion for statistics early developed itself in the life of our people...."[1] Estimates of the total value of all the real and personal property in the United States (exclusive of Louisiana Territory) were published as early as 1806 and a historical table of price fluctuations over the fifty-six year period from 1825 through 1880 was included in the "Annual Report of the Director of the Mint, 1881," (Horatio C. Burchard).[2] A growing interest in price and value information has resulted in the collection of data and the compilation and publication of time-series by numerous governmental agencies and private organizations. A wealth of time-price information is therefore available. Time-price series, some of which have been translated into indexes, have been published by various agencies for many individual products of numerous industries. These series are available for many of the products of agriculture, forestry, mining and metal products industries, manufacturing, construction and housing, and numerous

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1/ Francis A. Walker, quoted in "Historical Statistics of the United States 1789-1945," a Supplement to the Statistical Abstract of the United States, U. S. Department of Commerce, Bureau of the Census. 1949. p. v.

2/ Loc. cit., p. 1.

other areas.

The Board of Governors of the Federal Reserve System compiles and publishes extensive information relative to the price of money including Federal Reserve Bank Discount rates, maximum interest rates payable on time deposits, money market rates, bank rates on short-term business loans, member bank reserve requirements, security prices, margin requirements, bond and stock yields, etc. These data are derived from regular reports made to the Board by banks of the Federal Reserve System, Treasury Statements, and other sources and are published monthly in the Federal Reserve Bulletin.

Farm prices, income, expenditures, debts, etc., are collected and published monthly in Agricultural Marketing by the U. S. Department of Agriculture; statistics about metals and minerals are available from the Bureau of Mines (U.S. Department of the Interior) upon request; financial data on education are published in the Biennial Survey of Education by the Department of Health, Education and Welfare, and so on.

Price, quantity, and value data are collected by numerous agencies of the federal government, by industrial groups, by various special interest groups and by independent research groups. Some of the data have been converted into index numbers; many more have not. Of the indexes that have been compiled, several have gained prominence and warrant individual description.

Examples of Price Indexes

The Index of Change in Prices of Goods and Services Purchased by City Wage-Earner and Clerical-Worker Families to

Maintain Their Level of Living (better known as the "Consumer Price Index" or the "CPI") measures the average change in the retail prices of a "market basket" of approximately 300 goods and services purchased by wage-earner and clerical-worker families in 46 cities in the U.S.A. The goods and services in the market basket are identical in quantity and quality in consecutive pricing periods, except for substitutes that are introduced to replace items no longer available. The goods and services priced include foods, clothing, fuel, housefurnishings and other goods; the fees paid to doctors and dentists; rents; rates charged for utilities, and so on.

In addition to an "all-city average of all items," several sub-indexes are also published. These sub-indexes include indexes by city for twenty cities of all items and for food prices; the all-city average by type of commodity, i.e., food, housing, apparel, etc., and a regrouping by durable goods, nondurable goods, and all services.

There have been three major revisions (1934-36, World War II, 1950-52) of this index since it was first issued in 1919 (with data from 1913). The revisions involved (1) bringing the market basket up-to-date through studies of actual expenditures, (2) improving the sample, and (3) improving the methodology (calculation and pricing methods, specifications, etc.). The index numbers presently in effect (i.e., the latest revision) for this series use 1957-59 prices = 100 with 1952 weights (i.e., the relative

importance given to the approximately 300 goods and services included in the "market basket") since January 1953, 1949-50 weights for the period 1950 to 1952, 1934-36 weights for the period 1930 to 1949, 1917-19 weights from 1913 to 1925, and an average of the 1917-19 weights and the 1934-36 weights for the period 1926 to 1929. A new comprehensive revision of the index is in process which is scheduled to go into effect in the January 1964 index.

According to the Labor Law Reporter,[3/] the current index is

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3/ Labor Law Reporter, Union Contracts Arbitration 1, CCH 1960. ¶56,100.02.

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representative of the buying patterns in 1952 of 64% of the urban population and 40% of the total U. S. population.

The Consumers Price Index is prepared by the Bureau of Labor Statistics of the U. S. Department of Labor, and is available in publications of the Bureau which include:

Monthly Labor Review
Consumers Price Index (a separate monthly publication)
Statistical Supplement - Monthly Labor Review (annual beginning with 1959)

Secondary sources include publications of:

U.S. Department of Commerce, Office of Business Economics:
Survey of Current Business (monthly)
Supplement to the Survey of Current Business (biannually)

Board of Governors of the Federal Reserve System:
Federal Reserve Bulletin (monthly)

Commerce Clearing House:
Union Contracts Arbitration section of the Labor Law Reporter

The Wholesale Price Index (WPI) measures average changes in prices of about 2,200 commodities sold in primary markets in the United States. Wholesale, as used here, means sales in large lots. The prices apply as nearly as possible to the first large volume commercial transaction for each commodity, e.g., the selling prices of grains on the organized exchanges, of fresh produce at central auction markets, of machinery f.o.b. manufacturer's factory, and so forth. The weights used are based on the total value of shipments data (from the Industrial Censuses for 1958) f.o.b. production point, less interplant transfers, for the producing and processing sector of the economy. The prices used are those in effect on a particular day of the month, in most cases Tuesday of the week in which the 15th of the month falls.

This index has been published as a continuous series since 1890. At the time it was first constructed it was believed that it reflected the behavior of the price level more correctly than retail prices but with the passage of time its use as a "general price level index" has declined. Preference has developed for the use of the Consumers Price Index (CPI) and the index number derived from the calculation of Gross National Product in current and constant dollars and known as the "GNP deflators" (for a discussion of GNP deflators, see pages 22 to 25). One major cause of the shift was the realization that the Wholesale Price Index was not a true sample of the prices in the economy and that it was not particularly pertinent to any one group of consumers or businesses.[4/] It is not a measure of

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4/ Hearings before the Subcommittee on Economic Statistics... Part I, January 24, 1961. Government Price Statistics, pp. 61-64.

"wholesale prices," as its name implies, but a measure of some wholesale prices in specific markets.

Since "GNP deflators" are available only on a yearly and quarterly basis, no index is available to measure price-level movements on a current month-to-month basis. The Wholesale Price Index together with the Consumers Price Index, however, serve as an approximate indicator of the movement of the price level. Although use of the Wholesale Price Index has declined, the highly detailed and specific sub-indexes of individual industries, commodities, and product classes are widely used by manufacturers, by trade associations and by various government agencies in the production of other basic economic data. 5/

5/ Ibid., pp. 63-64.

For example, the U. S. Department of Commerce makes extensive use of the product class and commodity price data in the deflation of Gross National Product.

The detailed indexes are published in four different groupings of which the most detailed groups the individual products by industry. The other groupings are by stage of processing, durability of product, and special commodity groupings. The grouping by industry would be the most valuable for accounting purposes if adjustments in financial statements were to be made for changes in the prices of specific commodities rather than for changes in the price level.

The Wholesale Price Index is prepared by the U. S. Department of Labor, Bureau of Labor Statistics and is available

in publications of the Bureau including separate monthly and annual publication of the Wholesale Price Index. Secondary sources include those for the Consumers Price Index, except for the Labor Law Reporter which does not publish the Wholesale Price Index.

The U. S. Department of Commerce - Composite Construction Cost Index is a combination of various construction cost indexes weighted by the relative importance of the major classes of construction. The index is computed by dividing the total seasonally adjusted estimates of new construction activity in current prices by the same estimates expressed in 1957-59 prices.6/ The total in 1957-59 prices is obtained by adding the estimates for the various classes of construction that have been deflated separately.7/ Therefore, the composite index is the equivalent of a variably weighted index reflecting changes in both the component indexes and in the relative importance of the major classes of construction.8/ An index of this type, i.e., one that is

6/ Data are adjusted for seasonal effects by dividing the unadjusted datum for a given month by a constant percentage factor whose deviation from 100 registers the extent to which that period of the year is typically above or below some measure of "normal" because of seasonal influences.

7/ The term deflate is used in this paper in its technical sense meaning "to remove the effects of price changes." It refers to both increases and decreases in prices and therefore applies to both "deflation" and "inflation."

8/ Business Statistics, 1959 Supplement to the Survey of Current Business, U. S. Department of Commerce, Office of Business Economics. p. 219.

inherent in the relationship between an aggregate before deflation and the same aggregate after deflation, is frequently referred to as an implicit index.

This index is published in total only, with a 1957-59 base. Some of the component indexes that are used to deflate the various classes of construction, however, are published along with it. The component indexes do not all have the same base. Some of them use 1947-49 as a base while others use 1946 and still others use 1926-29 or 1913. Some of the component indexes are by type of construction, e.g., commercial and factory buildings of brick and concrete, brick and steel, frame, etc., others by city or in total.

Unlike the two indexes of commodity prices previously described which are indexes of output (goods or services produced), the Composite Construction Cost Index is a measure of the relative change in cost of the units of input, i.e., the cost per unit of the factors of production, of which wage rates and materials cost are the most important. If wage rates increase or the cost of a thousand board feet of lumber increases, this index number increases. This is the only index reviewed in this report that measures change in the cost of units of input. Any difference between the changes measured by an index number derived from input costs and those measured by one derived from commodity prices or output (for the same items) is due to changes in productivity. For example, if construction wage rates and contractor's profits both increased, a construction cost index

would also increase. It would, however, still be possible to have a decrease in the selling prices of completed construction work, provided that productivity increased more than wage rates and profits. In that case the effect on the general price level would be downward.

The individual indexes (many of which are privately compiled) used in deflating the current dollar figures for the different classes of construction include:

Residential building, except farm:
E.H. Boeckh and Associates

Farm buildings:
U.S. Department of Agriculture

Nonresidential building, selected types and military facilities:
American Appraisal Company
Fuller
Turner Construction Co.

Public utilities, selected types:
Interstate Commerce Commission
Handy-Whitman

Military facilities and highway:
U.S. Department of Commerce, Bureau of Public Roads

Sewer and water, conservation and development, and miscellaneous:
Associated General Contractors of America, Inc.
Engineering News-Record

The Composite Construction Cost Index is prepared by the Construction Industry Division, Business and Defense Services Administration of the U. S. Department of Commerce and is available in the following publications of the Department:

The Survey of Current Business
Supplements to the Survey of Current Business
Statistical Supplement to the Construction Review (published jointly by the U.S. Departments of Commerce and Labor on a monthly basis).

Monthly indexes are available from 1951 and annual indexes beginning with 1915.

GNP (Gross National Product) Implicit Price Deflator--

The elimination of the effects of price changes from the total dollar value of the Nation's production (so that the physical volume of all goods and services produced by the economy in different time periods can be compared) is accomplished through the use of numerous price indexes and price series, including the three foregoing indexes. The GNP Implicit Price Deflator is the resultant composite index implicit in the relationship of the figures before and after deflation, and is the most comprehensive price index available. It measures the relationship between (a) the total value of all goods and services produced in a given year expressed in current dollars, and (b) the total value of the same goods and services expressed in prices of a base year (constant dollars).

Gross National Product, in both current and constant prices, is subdivided into four classes of expenditures: personal consumption expenditures, gross private domestic investment, net exports of goods and services, and governmental purchases of goods and services. Each of these four classes is further subdivided into its component parts. In tables of GNP Implicit Price Deflators, however, deflators are not shown for gross private domestic investment and net exports of goods and services because significant components of these items include elements of opposite algebraic sign. Deflators for exports and for imports, taken

separately as independent series, are meaningful indicators of price movements. A deflator of the difference between exports and imports is, however, not reliable because a relatively small increase in the prices of exports, accompanied by a relatively small decrease in the prices of imports will cause a disproportionately large change in the movement of price of net exports. For example, suppose that in the base year exports totaled $1,000,000 and imports totaled $900,000 leaving net exports of $100,000. If exports increase by two percent (2%) while imports decrease by two percent (2%), net exports will increase by thirty eight percent (38%):

	Base Year	Percentage Increase (Decrease)	Current Year
Exports	$1,000,000	2%	$1,020,000
Imports	900,000	(2%)	882,000
Net exports	$ 100,000	38%	$ 138,000

For similar reasons, a deflator of "change in business inventories" is likely to be unreliable. Since "change in business inventories" is frequently a significant component of "gross private domestic investment," deflators are not calculated for the total of this subdivision of GNP, although they are presented for all of the other components of this segment. In the total picture of GNP, however, changes in business inventories and net exports of goods and services are not likely to be substantial and do not, therefore, disqualify the deflators for total GNP as indicators of price movements.

The GNP deflators are prepared by the U. S. Department of Commerce, Office of Business Economics and are available in

the Survey of Current Business and supplements.

The U. S. Income and Output supplement to the Survey of Current Business includes annual deflators from 1929 through 1957 and seasonally adjusted quarterly deflators from 1947 through 1957.

The National Income Number of the Survey of Current Business, published annually in July, brings up-to-date the information in the U. S. Income and Output supplement. Interim seasonally adjusted quarterly deflators are available in the "Annual Review Number," issued in February, for the preceding year.

Although final revised deflators are not available for any quarter until July of the following year, interim deflators can be computed by dividing the current dollar estimates (seasonally adjusted at annual rates) of the GNP by the constant dollar estimates that are published in the Survey of Current Business in the second month following the end of each quarter.

Data for accounting reports adjusted by deflators computed from the preliminary estimates of current and constant dollar GNP would not be materially different from amounts derived by using the revised estimates published in July of the following year. A test of 1959, 1960 and 1961 quarterly and annual deflators showed that the largest difference in the adjusted data would have been roughly one-half of one per cent.

The largest difference in the test period was for the quarter ended December 31, 1961. The preliminary estimates for this quarter first appeared in the February 1962 issue of the

Survey of Current Business (page S-1):

	billions of dollars
GNP in current dollars	542.2
GNP in constant (1954) dollars	464.6

The deflator implicit in the preliminary estimates is: 542.2 ÷ 464.6 = 116.7

The revised estimates in the July 1962 issue (page S-1, and table 1, pages 6-7; table 5, pages 8-9) are:

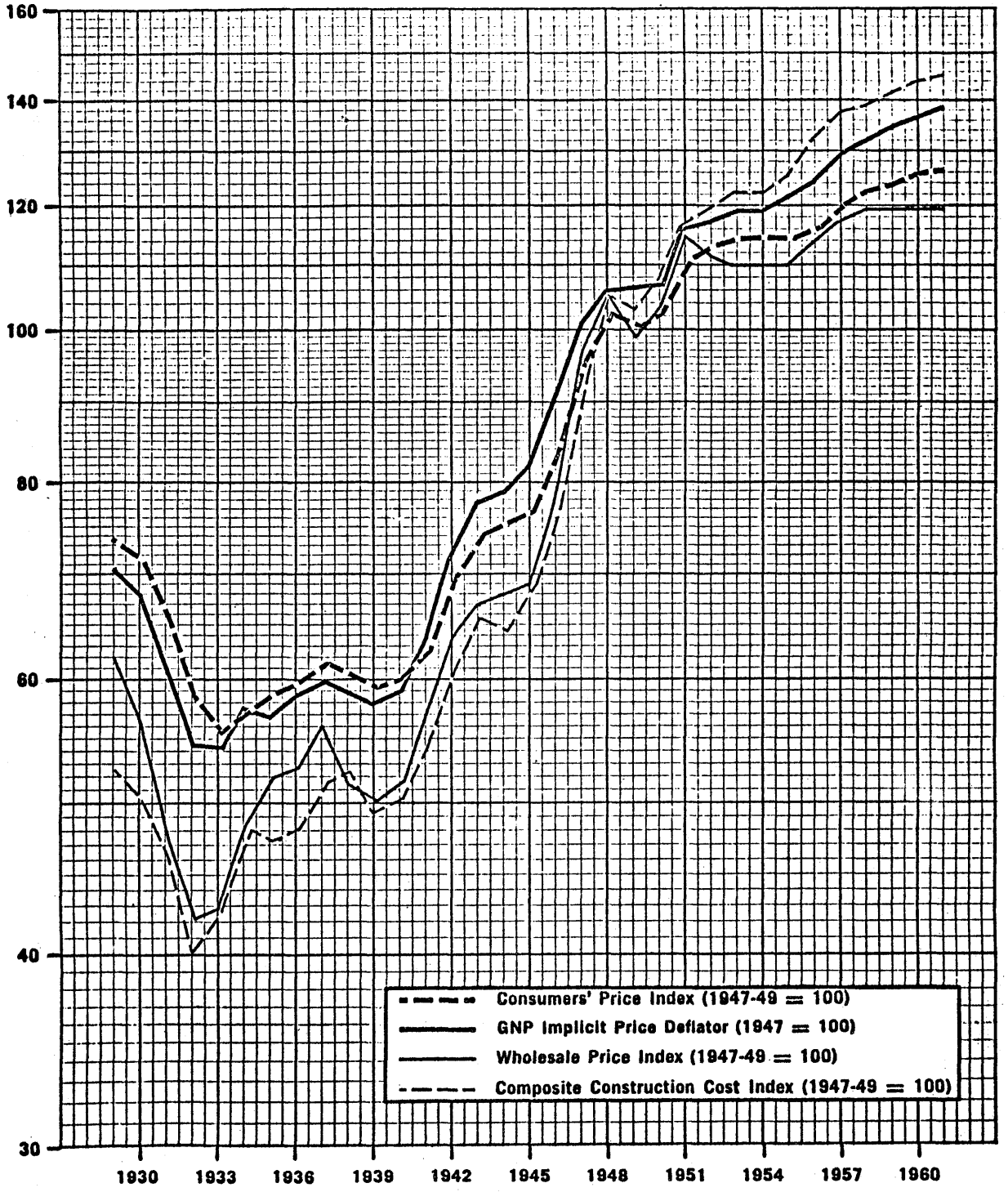
	billions of dollars
GNP in current dollars (revised)	538.6
GNP in constant (1954) dollars (revised)	463.4

The revised deflator, 116.2 is published in table 6 (page 9) of the July issue.

Measurement of Price Changes by U. S. Price Indexes

The four price indexes described in the previous section are charted in Figure 1 for the years 1929-1961 inclusive. Each of these indexes is designed to measure price changes in different groups of commodities: (1) the Consumer Price Index measures changes in prices of goods and services purchased by city wage-earner and clerical-worker families to maintain their level of living, (2) the Wholesale Price Index measures changes in the prices of nearly 2,200 commodities that are sold in primary markets, (3) the Composite Construction Cost Index is designed to show the changes in the cost of the units of input in the construction industry and (4) the GNP Implicit Price Deflator measures the price changes in all of the goods and services produced by the economy in a given year. Since these indexes do not attempt to

U. S. PRICE INDEXES



Source: U. S. Department of Commerce and U. S. Department of Labor Publications.

Figure 1.

measure changes in the same groups of prices, they cannot be expected to arrive at the same measurement.

Even though these indexes do not measure the changes in the same groups of prices, the curves (in Fig. 1) show parallel tendencies. The similarity in trends suggests that the increases in price levels indicated by these indexes are real.

That this inference is plausible can be demonstrated by a few admittedly rough but nevertheless valid comparisons. An increasing quantity of goods and services are available per person in the United States because the rate of growth shown in both the Index of Industrial Production and the Gross National Product (in constant dollars) has been greater than the rate of increase in the population. The rate of growth in the supply of money, however, has been much greater than in the output of goods and services so that proportionately more money has been available for the purchase of each unit of output. In addition, the rate of turnover of demand deposits has also increased, thereby enabling a given quantity of money to serve as a means of payment for an increasing volume of transactions.

As a consequence of these circumstances, a general rise in prices with an accompanying decline in the exchange value of money is almost inevitable. The statistics used in making the above comparisons can be found in the following publications:

Business Statistics, 1959 Supplement to the Survey of Current Business, U. S. Department of Commerce, Office of Business Economics.

Data for 1929-1958 inclusive:
Gross National Product in constant dollars, p. 3.
Index of Industrial Production, p. 8.
Population, p. 59.
Money supply, p. 96.

Annual rate of turnover of demand deposits 1943-1958 inclusive, p. 96.

Earlier annual deposit turnover rates are available in "Historical Statistics of the United States 1789-1945" op. cit., p. 269. These rates are not comparable with the later rates previously cited because of differences in the extent of coverage.

Federal Reserve Bulletin, February 1962.

Data subsequent to 1958:
Gross National Product in constant dollars, p. 230.
Index of Industrial Production, p. 216.
Money supply, p. 185.
Annual rate of turnover of demand deposits, p. 185.

CHAPTER 3

THE CRITERIA OF ADEQUATE PRICE INDEXES

Definition of Terms

The problem of an adequate index divides itself naturally into three parts: the universe, the sample, and the formula.

The universe -- The first step in the selection of an index is a precise definition of the concept to be measured so that the class of items that enter into the measurement can be clearly defined. The collection of all possible items that have the stated characteristics of the class of items defined is called a universe. The universe, then, is the totality /whole, aggregate, mass/ that is under observation and about which information is desired. The concept to be measured, precisely formulated, would determine the exact limits of the universe.

The sample -- In most cases it would be neither practical nor desirable to obtain data for the entire universe. The cost would be prohibitive and the time necessary to collect and process the data would result in an index that was out-of-date when prepared and, therefore, useful only as historical data. Valid conclusions can be drawn at more reasonable cost and in considerably less time by the careful selection of comparatively few items that are representative of all items in the universe. The items selected to represent the universe are called a sample. A properly selected sample would have the same characteristics as the universe and the index number

constructed from the sample would be representative of the index number obtainable from the entire universe.

The formula -- Once the universe has been defined and a representative sample selected, the data obtained from the sample are averaged in order to combine them into an index number. To avoid either overstating or understating the price change measured by the index number, the average must be weighted by the related quantities exchanged at these prices. The weighting scheme used is called the formula.

Much of the discussion that follows will be applicable whether adjustment is to be made in the financial reports for changes in prices of the specific items included in the accounts or for changes in the price level. The major emphasis, however, is on an index of the general level of prices.

The Universe

In order to adjust financial reports for changes in the specific prices that are applicable to the individual accounts, a number of indexes or other time-price series would be necessary, each one suitable to the item to be adjusted. The universes for these indexes would be the mass of measurable evidence of the prices of the particular goods and services or related groups of goods and services in the markets in which the company or industry buys those commodities. The universe for an index for one commodity in one market might require only price data. If two or more markets are involved, then the relative importance of prices in the different markets must be given

proper weight and both price and quantity data become important. If two or more commodities are combined in one index, whether more than one market is involved or not, both price and quantity data are needed to reflect the relative importance of the prices of the individual commodities. The universe for each of the individual indexes would be defined in terms of the specific account to be adjusted and the specific market in which the company or industry buys, borrows and attracts capital. The universe for each individual index would be comparatively simple to define; there would, however, be a number of them.

The universe for an index of the general level of prices encompasses the over-all group of goods and services exchanged in all segments of the economy in the periods being compared; the "universe" of an index limited to one segment of the economy uses only those exchanges applicable to that segment. The universe includes all transactions that place goods and services in the hands of the final consumers. The effect on the universe that results from interim transactions between the companies that perform the successive processing stages within an industry (e.g., extracting, refining, fabricating, assembling, and marketing) is reflected in the increases and decreases in inventories.

If accounting reports are adjusted for changes in the price level, the same index will be used for all adjustments. If the reports are to reflect changes in the general level of prices, the universe will include the aggregate underlying

data that represents measurable evidence of the quantity of goods and services that money will buy at the times of measurement. Because the dollar serves as a standard of exchange-value, the price of any commodity can be expressed in dollars; the price of dollars, however, can only be expressed in terms of the over-all group of goods and services for which it can be exchanged. The composition of the measurable evidence of the "price of dollars," therefore, will reflect an average of the prices of all goods and services exchanged in all segments of the economy, both public and private, in the ratio in which they affect the general level of prices.

Preferably, all measurements should rest on evidence that is reliable and subject to verification.[1/] Objective

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1/ Maurice Moonitz, "The Basic Postulates of Accounting," Accounting Research Study No. 1. American Institute of Certified Public Accountants. 1961, p. 50, Postulate C-2.

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evidence of the general level of prices is found in quantities and prices involved in exchange transactions that take place in the economy.

The economy encompasses all of the affairs of the nation that are concerned with its source of income, its expenditures, the development of its natural resources and so on.

Production, distribution, and consumption of wealth are all included. Because of the scope and complexity of the economy, care must be exercised to insure that all pertinent transactions are included in the universe while at the same time avoiding duplication which would give undue weight to some items. This involves a restricted use of the term exchange transaction.

Exchange transactions that affect the general level of prices (those reflected in national income and product accounting) might be compared to the transactions reflected in the consolidated earnings statement of a parent company and its subsidiaries after the elimination of intercompany items. If all of the successive stages of production and distribution were performed by companies within consolidated groups, then consolidated income would be reported only when the product was sold to the final user, and "intermediate products" would have their effect on net changes in business inventories. Consolidated earnings statements in this case would directly parallel national income and product accounts.

In addition to pinpointing the exchanges in each period that affect the general level of prices, the universes of these exchanges must have enough in common to warrant comparison. The rate at which the goods and services available to the consumer are improved, changed, or replaced makes it necessary to select a new base period at frequent intervals because the prices being compared must apply to comparable goods and services if the index is to measure changes in prices.

No definite life span over which a base period is valid can be established; that is determined by the degree and scope of change in the universe in subsequent time periods.

> ...In a stable society, revisions could be extremely infrequent; in the rapidly changing American economy, a revision once in a decade or more (as has more than once been the case with the Farm Indexes and the Consumer Price Index) is too infrequent. The rapid pace of introduction of new products in the United States, the large demographic changes in recent decades, the revolution in production methods - these are instances of the changes that dictate frequent revision of weight bases. 2/

2/ Hearings before the Subcommittee on Economic Statistics... Part I, Jan. 24, 1961, Government Price Statistics, p. 31.

With comparable universes in the two periods, the quantities of most goods and services will be in terms of the units in which those goods and services are marketed. When the exchange transactions that affect the price level have been identified, and comparable quantity units determined, then the prices that prevail for the quantities exchanged can be realistically assigned on a consistent basis.

The collection of all of the prices and quantities necessary for a complete enumeration of the items in the universes described here is a practical impossibility. Therefore, a complete enumeration is replaced by a sample of measures which describe the group as a whole.

The Sample

Inherent in the use of a sample is the assumption that the part of the universe measured is valid evidence of a

measure of the whole. The sample therefore should have the same characteristics as the universe if the index number constructed from the sample is to be representative of one obtainable from the entire universe. There are two firmly established methods of selecting a sample: (1) judgmental sampling, and (2) probability sampling.3/

3/ The methods used to select the samples for the currently compiled indexes reviewed in this study are discussed in Chapter 4.

Judgmental samples -- The choice of items in a judgmental sample is made by competent individuals experienced in the area after careful consideration of all the factors related to the problem. Consultation with manufacturers and trade associations, review of census data, and surveys of the purchasing habits of individuals are some of the devices used as preparation for the selection of representative judgmental samples. Some of the best known indexes currently compiled are based on judgmental samples; at least one of these makes use of a survey of the type mentioned above.

Accountants use judgmental samples in testing all types of accounting data and they base sound decisions on the limited data selected. The interlocking characteristics of accounting data increase the likelihood that the auditors' tests will produce reliable results. Since the data from which index numbers are constructed do not have these interlocking characteristics, census data, income tax returns and other "benchmarks" are used

to determine whether the index number is reasonable. Under judgmental sampling, however, there is no way in which a numerical value can be assigned to the degree of confidence that can be placed in the sample. The user of an index based on judgmental sampling relies on knowledgeable specialists to evaluate the index and determine whether it is accurate enough for his purpose.

Probability samples -- Inherent in the use of probability samples is the assumption that the validity of using the part as a measure of the whole can be determined within limits that can be estimated in advance if the choice of items is based on the mathematics of probability. When this type of sampling is used, the number of possible selections from the universe, and the importance of the item (as indicated by the weight assigned to it) determine the "chance of selection." For example, in tossing a coin there are two possibilities for each toss, a head or a tail, and each has an equal chance or a probability of one-half, whereas, in throwing a die there are six possibilities for each toss so the probability of any particular number from one to six is one-sixth. In more complex situations all possibilities are not equally likely. Because of the method of selection, bias in the person making the selection does not affect the sample. This type of sample is representative of its universe because it is designed to give the same weight to each item (or group of items) in the sample as it has in the universe.

Collecting the Sample

An accurate index number requires accurate data for its computation. The quantitative data used in compiling index numbers

do not always originate in measurements taken by those using the data; they are usually reported by others. The collection of data for a price index depends on the cooperation obtained from thousands of individuals and organizations who furnish the information. In order for the collecting agency to receive the data it wants, the commodities, their prices and the related quantities must be clearly defined in a manner that will convey the same meaning to those who furnish the data and those who use it.

Identification of commodites -- In order for an index to reflect only price changes, the price quotations that are being compared should apply to comparable goods and services. If prices for dissimilar goods are compared, the resultant index will reflect, in part, the effects of variables other than prices. For this reason the specifications should be in enough detail to identify the goods and services for which data are requested so that the user will get the information he wants.

One of the chief problems of index number construction is insuring that the commodities being priced in successive periods have the same qualities. To achieve this end, specifications should be and are drawn up in elaborate detail (e.g., the specifications for a single producers' durable good may run to several pages). To provide for the diversity of the market, the specifications for some items make allowance for choices by expressing some features of the product as ranges. with the limits of the ranges set to minimize differences in quality among the

products within the range.[4] When a commodity is displaced in

[4] Ethel D. Hoover, "The CPI and Problems of Quality Change." Monthly Labor Review, Nov. 1961, p. 1177.

the market by another having different qualities, the newcomer is substituted in the index for the old by "linking."

Linking (or "bumping" as it is known in Canada) requires prices on the same date for products having the old quality and those having the new. In those cases where the full difference in price is due to the quality difference, the price measure based on the new quality is tied to the preceding one by "factoring out" the difference in price.[5] An example of the method used to

[5] Ibid., p. 1178.

factor out price differences due entirely to quality change follows:

	Base Period	Period 1.	Period 2.
Reported price:			
Original item before quality change (old)	$3.00	$3.60	-
Substitute commodity that has different qualities (newcomer)	-	5.00	$4.00
Price relative	-	$\frac{3.60}{3.00} \times 100 = 120$	$\frac{4.00}{5.00} \times 100 = 80$
Price index	100	120	$\frac{120 \times 80}{100} = 96$

In other cases there may be a change in price that is not due entirely to a change in quality. This frequently occurs in the case of commodities that have a model change every year. Similar changes take place in other commodities at irregular time intervals. Calculating price changes for these items requires a more elaborate procedure. First an adjustment is made for any change in price that is due to change in quality. To do this, industry committees are often consulted in the U.S. concerning the effect on prices of changes in technology and quality. Next the adjusted price is compared directly with the price of the former item in the preceding period. In the following period the new variety is "linked" into the index, displacing the old one completely.

As an example of this type of adjustment, suppose that a new safety device is installed as standard equipment on cars marketed in the current period and this device is identifiable with an increase in the price of cars of $50. The current period price would be reduced by $50 before comparing the current period with the preceding period so that the prices compared would represent comparable commodities. In the following period, the price of the car <u>including</u> the safety device would be used for comparison in both periods. This method of adjusting the sample can be used with any of the current methods of index number construction.

In many cases a given commodity is considered to be representative of a group of similar commodities so that the

importance of the sample for this item is magnified by the weight assigned to the entire group which it represents.

Tangible products can be readily identified and counted; services /intangible products/, which are becoming increasingly important in the U.S., present more difficult problems of measurement. Because services are intangible, the units cannot always be readily identified and no definitive method has been devised to insure that similar units are being compared. Services may be divided into two major groups: (1) those for which there are no market transactions to provide measures of prices and quantities, and (2) those for which there are, i.e., those performed on a fee basis.

A substantial volume of services is purchased by the community through the payment of taxes. For these services there are no market transactions in which a known "quantity" of service is exchanged for a known quantity of money. The quantity units of many of these services are abstract ideas. Agreement on the definition of the unit has not been reached. One method used to estimate the quantity exchanged in these cases is to analyze the component parts or input units.

Public school education is a prime example of a service that is purchased by the community through the payment of taxes. No fee is paid by the parents. There are no market transactions to provide measures of the price and quantity of education exchanged. A unit of education is an abstract idea; there is no agreement on how to measure the output of the public school

system. Since no way has been devised to measure the output units, measurement of the input units is substituted. The output, education, is assumed to be worth its cost. The costs of similar input units in the two periods are compared. For example, the cost of salaries for teachers with similar education and teaching experience are weighted by the number of teachers in that classification. The use of the cost of input units does not, however, give weight to changes (if any) in factors such as the productivity of teachers or the quality of instruction given. Accordingly the related effect on the quality of a "unit of education" is not reported or assessed. This method (the use of the costs of inputs) is, however, a good practical approach to a complicated problem for which no better solution has been devised.

Services that are performed on a fee basis include both those for which the unit of output can be readily measured (e.g., number of sheets laundered) and those for which it cannot (e.g., advice of a physician). In both cases the billing unit is used as the quantity unit even when billing is based on units of input (e.g., hours spent on an audit). The prices used are actual "exchange prices" (or fees) and present no problem. When billing is based on input units, however, the quantity data used will have the shortcomings mentioned in the example of public school education.

The level of prices and the standard of living. A price index does not and cannot be expected to measure changes in customer satisfaction, economic welfare, utility, or other subjective concepts that are related to changes in the "standard of

living." A price index measures directly the variations in the exchange-prices of goods and services, and indirectly the variations in the exchange-value of money. The "standard of living" is a different concept, related to people's wants and their ability to satisfy them. Since production has increased more rapidly than population in the United States, the standard of living would no doubt have risen whether the price level had increased, decreased, or remained constant. Changes in technology or quality may make a product more acceptable for some purposes and less acceptable for others. This will no doubt affect the standard of living directly but can have only an indirect effect on price-level measurements through its effect on the supply of and demand for the good or service, and hence on its exchange-price. The only factor that makes technical and quality changes directly pertinent to price index construction is the problem they create in determining whether the prices quoted are in fact applicable to comparable units.

Technological change and price comparisons. To measure changes in price, and not in some other variable, the units priced should be the basic units actually exchanged in the market and not a hypothetical unit of satisfaction received. Take the case of a doctor and his patients. Assume that the doctor charges a standard fee of five dollars for an office call. His patients have different ailments and therefore receive different treatments, but all pay the same fee for an office call. More rapid advance of medical technology in some fields may result in the

rapid recovery of some patients while others recover slowly or not at all. There is, however, no reason for this to affect the statistical measure of the price of medical services. The point at which the transaction takes place between the doctor and the patient is the point of measurement for the exchange transaction entering into the pattern of prices. If, at a later date, the fee should be raised to six dollars, the increase should and would be reflected in a properly constructed index.

Publication of the report of the Price Statistics Review Committee early in 1961 promoted considerable interest among economists and statisticians in the problems of price-level measurement created by technological and quality changes in goods and services.6/ The Monthly Labor Review has since published technical

6/ This committee was appointed in 1959 by the National Bureau of Economic Research, at the request of the Bureau of the Budget, to review critically the price indexes of the Federal Government.

articles on this subject that were stimulated by the report. One of these, "The problem of quality changes and index numbers" by Milton Gilbert of the Bank for International Settlement, has had considerable influence on this discussion.7/

7/ Sept. 1961, pp. 992-97. Also available as reprint No. 2375.

Prices -- The concept of price is not uniform. Prices may be quoted before or after deducting discounts. Sales and excise taxes, freight, and handling charges are among the items

that may or may not be included in price quotations. Since two sets of prices are needed for the construction of a price index number - those in effect in the base period and in the period with which the base is being compared - "price" must mean the same thing in both cases. These prices should be actual exchange prices for comparable quantities of goods and services (e.g., prices for units sold in carload lots should not be compared with the prices for units sold by the dozen).

Information concerning unit prices is available in more detail than the related quantities sold at those prices, especially for consumer goods that are advertised in the daily newspapers. In sampling prices, consideration should be given to the effect of bargain sales and discounts on the actual prices paid.

It is sometimes necessary to use catalog, quoted, or other list-type prices that differ from actual exchange prices. This may result in an error in the index number, but the error is ordinarily of little consequence. The reason for this assertion is that as long as the numerator and denominator are both biased (or "in error") in the same direction, the bias tends to cancel out in the result. If the bias is proportionately the same in both numerator and denominator, the resultant "index number" is precisely accurate:

Period	Actual		Catalog	
	Prices	Index	Prices	Index
$\frac{\text{Current}}{\text{Base}}$		$\frac{300}{200} = 150$		$\frac{330}{220} = 150$

In this case, both numerator and denominator are in error by 10%. The only case in which biases in the data underlying index-number construction are significant for accounting uses are those in which the biases are both (a) erratic and (b) unpredictable (indeterminate).

The Formula

The data obtained from the samples are combined into index numbers by means of weighted averages which are referred to as formulas. Many formulas have been proposed and used in the construction of index numbers; they differ in the method of assigning weights to the prices. The "best" formula is one that results in an index that is mathematically unbiased so that the change measured by the index will be neither overstated nor understated.

The following symbols are conventionally used by statisticians in expressing these formulas:

p = the price of a commodity or service.

q = the quantity of that commodity or service.

p_o, q_o = the price, quantity of the commodity in the base period.

p_1, q_1 = the price, quantity of the commodity in a period other than the base period.

p_a, q_a = the price, quantity of a commodity in some "average" period; or the averages over some selected period.

Σ = (Sigma) the sum of all the terms similar to that following the Σ.

Thus, $\Sigma p_o q_o$ = the summation of the base year values (base year prices multiplied by base year quantities) for all commodities sampled.

In the case of a single commodity, a simple unweighted arithmetic average is sometimes used, which may be expressed by $\frac{p_1}{p_o} \times 100$.

The commonly used indexes described in Chapter 2 are classified by type of formula in the discussion in Chapter 4 where they are analyzed and evaluated. The four most frequently used formulas are Laspeyres's, Paasche's, Fisher's, and a fixed-weight formula that is a variation of Laspeyres's formula. Notice that in each formula, the same "q" factors appear in both the numerator and denominator, hence cancel out to leave a ratio of "p" factors weighted by the "q" factors.

Laspeyres's formula -- This formula averages the change in the prices of fixed quantities of specified commodities; the quantities are fixed because they are base period quantities, i.e., the weights are from the base period.

$$\text{Laspeyres's}: \frac{\sum p_1 q_o}{\sum p_o q_o}$$

Paasche's formula -- This formula averages the change in the prices of changing quantities of specified commodities; the quantities change each period because the current period quantities are used, i.e., the weights are from the current period.

$$\text{Paasche's}: \frac{\sum p_1 q_1}{\sum p_o q_1}$$

Fisher's formula -- This formula is a geometric average of the Laspeyres and Paasche formulas; therefore both base period and current quantities are used as weights.

$$\text{Fisher's}: \sqrt{\frac{\sum p_1 q_o}{\sum p_o q_o} \times \frac{\sum p_1 q_1}{\sum p_o q_1}}$$

Fixed-Weight formula -- This formula, like Laspeyres's formula, averages the change in the prices of fixed quantities of specified commodities. It differs from the Laspeyres's formula in that the quantities are from a fixed period that is not the base period. /It is often referred to as a "Laspeyres's type" formula./

$$\text{Fixed-Weight: } \frac{\sum p_1 q_a}{\sum p_o q_a}$$

The four formulas are presented above in what may be called their "definitional form," as various combinations of value sums (i.e., quantities of particular goods and services multiplied by their prices). This form is used here in order to simplify the discussion. In the actual construction of price indexes, a more complicated "computational form" of the formula is used which may be described as a value weighted price relative. For example, for the Laspeyres formula, $\frac{\sum p_1 q_o}{\sum p_o q_o}$, the computational form is $\frac{\sum p_o q_o \frac{p_1}{p_o}}{\sum p_o q_o}$; the computation requires a knowledge of the base year value, "$p_o q_o$," and a relative "$\frac{p_1}{p_o}$" which measures the change in prices. When the computation of the index is complete, the results are identical with the concept in the "definitional form" of the formulas used in this discussion.

Characteristics of the Formulas

Tests of index numbers -- The ratios of quantity weighted prices for a single commodity have certain properties which cannot all be exhibited by an index number for a group of commodities. These properties, which were originally used

by Irving Fisher and W. M. Persons[8/] as tests to be used in the

8/ Indices of General Business Conditions, Harvard University Press, 1919.

choice among different formulas for an index number, are now used merely to describe the numerical characteristics of the various formulas. Fisher advocated what he called the "time reversal test" and the "factor reversal test" as the most important, whereas Persons placed more emphasis on the "circular test."

The first test is the time reversal test. If prices in 1960 are double those in 1930, then prices in 1930 are half of those in 1960. This requires that the backward index number (e.g., from 1960 to 1930) be the reciprocal of the forward index number from 1930 to 1960. The test used to determine if the two index numbers are in fact reciprocals is the time reversal test. This reciprocal quality will permit price data to be carried backward or forward in time, while various relationships are exactly maintained.

The "backward" index numbers derived when the Fisher and the Fixed-Weight formulas are used are the reciprocals of the "forward" index numbers. This is not true when either the Laspeyres or the Paasche formula is used.

The second test is the factor reversal test. Not only may prices change, but so may the quantities of goods and services. Suppose a given formula applied to prices in two periods of time yields an index of 200, and the same formula applied to the related quantities yields an index of 300 (i.e., prices, on the

average have doubled, while quantities exchanged have tripled), then it follows that the total market value in the second period is six times the market value in the first period.

This truism in the case of a single commodity must be modified for the Laspeyres and Paasche formulas. The ratio of the market value at two dates can be expressed as the product of a price index and a quantity index[9/] in two ways:

9/ The quantity index formula associated with a price index formula can be obtained from the latter by interchanging the letters p and q, (price and quantity) while the subscripts remain fixed in place.

$$(1)\quad \frac{\sum p_1 q_1}{\sum p_0 q_0} = \frac{\sum p_1 q_0}{\sum p_0 q_0} \times \frac{\sum q_1 p_1}{\sum q_0 p_1} = L(p) \times P(q)$$

i.e., a Laspeyres price index - L(p) - multiplied by a Paasche quantity index - P(q).

$$(2)\quad \frac{\sum p_1 q_1}{\sum p_0 q_0} = \frac{\sum p_1 q_1}{\sum p_0 q_1} \times \frac{\sum q_1 p_0}{\sum q_0 p_0} = P(p) \times L(q)$$

i.e., a Paasche price index - P(p) - multiplied by a Laspeyres quantity index - L(q).

The value ratios cannot be equated to the product of the price and quantity indexes of the same formula, but they are the product of a Laspeyres index and a Paasche index. The Fisher formula which is the geometric mean of the Laspeyres and Paasche index satisfied the factor reversal test because of the truisms (1) and (2). When the differences between the Laspeyres and Paasche indexes are not large, the value ratios may be approximately equal either to the product of the two Laspeyres indexes or to the product of the two Paasche indexes. For example, assume the following prices and quantities for three commodities in two different years:

Commodity	Given Data				Multiplications			
	p_o	q_o	p_1	q_1	p_oq_o	p_oq_1	p_1q_o	p_1q_1
A	10	100	12	100	1,000	1,000	1,200	1,200
B	12	5,000	17	10,000	60,000	120,000	85,000	170,000
C	20	400	18	500	8,000	10,000	7,200	9,000
Σ					69,000	131,000	93,400	180,200

The Laspeyres formula yields the following index numbers when applied to these data:

Price index number:

$$\frac{\Sigma p_1q_1}{\Sigma p_oq_o} = \frac{93,400}{69,000} = 135$$

Quantity index number:

$$\frac{\Sigma q_1p_o}{\Sigma q_op_o} = \frac{131,000}{69,000} = 190$$

The product of these two index numbers (135 x 190) is 257. However, a direct comparison of the total market value in the two periods, $\frac{\Sigma p_1q_1}{\Sigma p_oq_o}$, yields an index of 261 indicating that the Laspeyres and Paasche price indexes were not widely different.

The third test is the circular test. This test presumes that the base of a series of three or more index numbers should be shiftable at will and without error. Only formulas using constant weights can satisfy this test, and no index series can satisfy it over long periods of time because the weights are changed at varying intervals. The circular test is currently regarded as important, however, in the construction of a monthly index number that will be consistent with an annual index.

The circular test requires that a series of three or more index numbers form a closed series and is actually an extention of the time reversal test. For example, the index number from period 0 to 1, multiplied by the index number from period 1 to 2, multiplied by the index number from 2 back to 0, should equal unity.

In general, then, if there are n distinct periods, numbered 1, 2, ..., n-1, n, then the index numbers will be for the period 0 to 1, 1 to 2, 2 to 3, and so on to n-1 and n, and finallly for the period n back to 0. The product of all these index numbers should be equal to 1 to satisfy this test. This test is the circular test.

The only formulas that satisfy the circular test are fixed-weight formulas.

Additivity of component indexes -- The use of index numbers in the analysis of national income data has resulted in the favor of index formulas in which the grand total is the simple weighted sum of the component indexes. The Laspeyres, Paasche, and Fixed-Weight formulas have this property but the Fisher formula does not. In the example on page 50, the price index number is the weighted sum of the price index numbers for each of the three commodities--A, B, and C,--where the weights are the values at the base date:[10/]

10/ See Richard Stone, Quantity and Price Indexes in National Accounts, Organization for European Economic Cooperation, Paris, 1956, pp. 37-39.

$$\frac{\Sigma p_1 q_o}{\Sigma p_o q_o} = \frac{93,400}{69,000} = \frac{\underbrace{1,000 \times \frac{12}{10}}_{\text{A}} + \underbrace{60,000 \times \frac{17}{12}}_{\text{B}} + \underbrace{8,000 \times \frac{18}{20}}_{\text{C}}}{\underbrace{1,000 + 60,000 + 8,000}_{\text{Index for Commodity}}}$$

For each commodity, we have in the numerator, the exchange value in the base year ($p_o q_o$) multiplied by the ratio of the price in period 1 (p_1) to the price in period 0 (p_o).

An economic viewpoint -- Some mathematical economists in studying the changes in price levels have concluded that, under certain conditions with respect to tastes and real income, the Laspeyres formula results in an index number that is greater than the "true" one, i.e., it is biased upward, while the Paasche formula is biased in the opposite direction and the unbiased index lies somewhere between the two.[11/] Under these same conditions, Fisher's formula approximates the "true" index because it lies between the Laspeyres and Paasche formulas.

11/ See Robin Marris, Economic Arithmetic, (Macmillan & Co., Ltd., 1958), pp. 257-62; also Michael J. Brennan, Preface to Econometrics (South-Western Publishing Company, 1960) p. 369.

In a practical sense, these conditions serve to limit the time over which one base period may be used, because tastes and real income are affected in the long run by factors that in the short run are either absent or not material. If the given period is "too far away" from the base period, then the index number computed on the base period may not be very accurate. For short periods of time, however, the Fisher index number

can be an accurate indicator of the change in the level of prices compared to the base period.

Small changes -- If the actual change in prices was quite small, use of the Laspeyres formula might result in a slight move in one direction while the Paasche formula resulted in a slight move in the other direction. This possibility of different "readings" as to direction of change by two index numbers may lead to confusion or uncertainty, of course, but it is not significant because it can only occur when the changes themselves are small and therefore not of much consequence one way or the other.

Representative weights -- Theoretically, the quantity data used to weight a price index for an economy characterized by changing expenditure patterns should give effect to the conditions existing in both of the periods being compared.12/

12/ United States Department of Labor, Wholesale Price Index, Reprint of Chapter 10 BLS Bulletin No. 1168, pp. 9-10. "In theory, most authorities agree that the ideal formula...would be one in which the weights represent the conditions existing in both of the periods which are compared...." Also Bruce D. Mudgett, Index Numbers, (John Wiley & Sons, Inc., 1951), pp. 37-40.

The Fisher formula is the only one of the four that takes into consideration the actual conditions existing in both of the periods being compared.

The Laspeyres formula uses quantity data from the base period but ignores the given period quantities, a procedure which gives too much weight to commodities which were significant in the base period but are of minor importance in the given period.

The contrary "bias" is found in the Paasche formula which uses quantity data from the given period but ignores the base period quantities.

The Fixed-Weight formula does not give effect to the conditions existing in either the base or given periods. The time period from which the quantity data is selected may be determined in any one of several ways, including (among others) the availability of census data and other benchmarks, or Congressional appropriation of funds for a survey of purchasing habits.

The time and cost needed to gather the necessary data often play an important role in the selection of the particular formula used in compiling an index because the formulas do not all require the same amount of data. All price index formulas require both base year and given year prices; they differ, however, in the quantity data needed. For the Laspeyres formula, only base year quantities are needed; once these have been collected, additional quantity data are unnecessary. For the Fixed-Weight formula, the selected quantity data are needed; once these have been collected, no additional quantity data are required. For the Paasche and Fisher formulas, given year quantities are needed which must be collected each year. The Fisher formula also requires base year quantities. The gathering of data for the Paasche and Fisher formulas costs more in both time and money than for the other formulas. As a result they are less frequently used.

Shifting Base Index - The Chain Index Method

There are two methods of constructing indexes: (1) by use of a fixed base, and (2) by use of a shifting base or "chain." In the United States all of the well-known indexes are of the fixed base variety, i.e., they measure changes in prices in a succession of years as compared with a base period. If, for example, 1950 is the base, then the indexes for 1955, for 1960, and for 1965 relate prices in the later years to prices in 1950. The less familiar "chain" method, by contrast, uses a new base for each successive link in the chain.[13/] It relates prices in 1955 to those prevailing in 1954, those in 1960 to those prevailing in 1959, and those in 1965 to those prevailing in 1964. The chain index method provides for the shortest possible time interval by comparing each period with the next preceding period.

13/ The term "chain index" is also used to refer to the "chaining" together of a series of fixed base indexes to make one index, but this is not the sense in which the term is used here. The Consumer Price Index and the Wholesale Price Index are examples of the joining together of a series of fixed base indexes.

Several groups of goods and services that affect the price level in the two periods being compared can be identified:

1. Those existing in both the base period and the period with which the base period is being compared.

2. Those existing in the given period that are essentially modifications of goods and services that existed in the base period.

3. Those existing in the given period that were introduced subsequent to the base period (new goods and services).

4. Those existing in the base period that are not available in the given period (discontinued items).

Changes in technology, tastes, styles, and quality are reflected in these groups. The prices of all of the goods and services in the above groups that are in existence at the times under consideration affect the general level of prices.

An index of the general level of prices is constructed from a sample that is representative of all of the goods and services exchanged in the economy. In a reliable index, the bulk of the commodities will be those in the first group, i.e., those existing in both the base period and the given period. The larger the total market value of this group relative to the total market values of all goods and services in the two periods, the more accurate the index number will be as a measure of the change in prices. The relative value of this group will ordinarily increase as the time interval between the two periods is shortened because there will be less opportunity for the introduction of new products (group 3), the modification of existing commodities (group 2), or the disappearance of goods from the market (group 4). The chain index method achieves the maximum uniformity between the goods and services that affect the price level in the two periods by comparing adjacent time periods.

The chain method also provides a means by which commodities which are being replaced in the economy (i.e., group 4) can be easily replaced in the index; and new commodities introduced in the economy (i.e., group 3) can be introduced into the index within a comparatively short time.

More specifically, new commodities would be introduced into the chain index in the period following the period in which they were first marketed. In this way the time lag between their effect on the price level and their effect on the index would be reduced to one time period. At the time they are introduced into the index, there would be exchange transactions to supply price quotations for these commodities for both the base period (i.e., the period in which they were first marketed) and for the given period. Unless new commodities represented a significant portion of the total value of the exchange transactions in the period in which they were first marketed, which would be most unusual, the effect on the index would be immaterial.

In addition, the removal of commodities that are discontinued is simplified by revising the base each year. If this were done, the index number for the period following the last period in which the commodities were marketed would be the only one affected. Furthermore the importance of commodities discontinued from one year to the next cannot be very great because commodities that sell in substantial quantities will not be discontinued by the producers except under extraordinary circumstances. As a consequence the commodities that are discontinued normally constitute a negligible part of the whole, minimizing further the effect on the reliability of the related indexes.

If monthly or quarterly indexes are needed, the chain index method could be modified to provide for the seasonal

character of the availability of many commodities. Instead of using the adjacent previous month (or quarter) as the base period, the same month (or quarter) in the preceding year could be used as the base.

A chain index retains contact continuously with the prices and quantities of the goods and services actually exchanged in the economy over the years. Over a period of years, a fixed base index, on the other hand, loses contact with the relative importance of the new commodities introduced and the older commodities that disappear from the market in the interlude between the periods being compared. In this sense the chain index is clearly superior.

A chain index cannot completely eliminate bias resulting from the introduction of new commodities and the discontinuance of old ones, but it can reduce it to insignificance. Since insignificant errors cannot have a material effect on statement presentation, a price index prepared in this manner may prove more satisfactory for the accountants' need for indexes that reflect changes in the price level, and in nothing else.

There is disagreement among economists and statisticians concerning the theoretical accuracy of the chain index method as compared with the fixed base method. There are distinguished authorities on both sides of the issue. The fixed base method has prevailed in this country due to practical considerations. For one thing it requires fewer data, and therefore it costs less to compile. Also, prior to the advent of rapid communications and electronic data processing equipment, there was no

practical method to obtain and use quantity weights sufficiently current for application of the chain method to a broad based index. Because of the disagreement as to which approach is theoretically superior, there has been no pressure from any influential group to spend the extra money for the adoption of the chain method.

At the present time there is more of a consensus in favor of chain indexes for particular small classes of commodities, especially in those cases where the specifications change frequently. In actual practice the indexes for many classes of commodities, e.g., men's shoes and agricultural machinery, are almost chains in the sense of this section of the report, because of the necessity for frequent linking of the index due to new specifications.

Rapid data gathering and data processing methods are now available which make a revival of interest in the "chain index" feasible. The expanding needs of business, government, accountants, and others indicate a need for more accurate indexes of price movements. Because of its many advantages, the chain index method should be experimented with and its strengths and weaknesses more satisfactorily determined.

Limited Time Span for Reliable Measurement

Neither the chain method nor the fixed base method of index number construction provides a method of measuring the percentage change in prices between two periods in which the bulk of the goods and services exchanged in each period are unique. A reliable price index cannot compare the prices of

commodities in one period with prices in other periods in which comparable products do not exist. The rate of technological change, therefore, is one important factor that serves to limit the time span over which price-changes can be reliably measured by a given series of index numbers. It may be possible, for example, to determine whether the price level was higher or lower in the 1920's than in 1963, but the precision of the measure of change is open to serious question because of the dissimilarity in the goods and services available in the two periods.

The rate at which new commodities are introduced into the economy and old ones are discontinued is neither uniform nor systematic. For this reason, a definite limit cannot be established for the number of years over which price level changes can be reliably measured. There is reason to believe, however, that comparisons of current price levels with time periods preceding World War II would not be sufficiently reliable for accounting purposes. This assertion is based on the *prima facie* evidence of the numerous goods and services currently available that originated in discoveries and innovations attributable to the war effort and to postwar developments. To the extent that these goods and services represent a large portion of the dollar value of current exchange transactions, the precision of comparisons of current price levels with those prevailing in periods prior to World War II are unreliable.

CHAPTER 4

CRITIQUE OF CURRENTLY COMPILED INDEXES AND RECOMMENDATIONS

Critique of Currently Compiled Indexes

The Consumer Price Index -- The index known as the Consumer Price Index measures change in prices of goods and services purchased by city wage-earner and clerical-worker families to maintain their level of living. Their "level of living" is represented by a market basket of approximately 300 goods and services selected as a result of a study of their buying habits. This index does not attempt to measure price changes for any group of consumers other than city wage-earner and clerical-worker families. To the extent that others have similar purchasing habits, this index may indicate the price changes that affect them. However, caution should be used when applying this index as a measure of price changes that it does not attempt to cover.

The universe of this index is described in its official title "The Index of Change in Prices of Goods and Services Purchased by City Wage-Earner and Clerical-Worker Families to Maintain Their Level of Living." The shorter title by which it is known, "The Consumer Price Index," is inaccurate in that it indicates a wider universe than is actually used.

The market basket of goods and servies priced in this index has been revised less often than once every ten years. The goods and services available to consumers are improved, changed, or replaced in our economy at a rate which out-dates a

base period more frequently than this index is revised. The Bureau of Labor Statistics makes adjustments to the market basket to compensate for these changes where possible. There is, however, no adequate measure of the effect on the index numbers caused by the use of an obsolete base.

The sample used in the "Consumer Price Index" is a complex which incorporates probability, semiprobability and judgmental sampling for different parts of the index.[1] The Commissioner of Labor Statistics believes that "It is intrinsically impossible to obtain sampling errors, in the usual sense, for the Consumer Price Index."[2] As a result, it is not possible to tell how closely this index approximates an index of the complete universe.

The Bureau of Labor Statistics has compiled the Consumers Price Index for nearly half a century. In that time the index has been thoroughly reviewed, scrutinized in detail, re-examined and evaluated many times. Based on the experience and reputation of the Bureau, it is usually judged to be "good" without attaching a numerical value to its precision.

1/ Ewan Clague, "Comment" on "Food Prices and the Bureau of Labor Statistics" by William H. Kruskal and Lester G. Telser, Journal of Business, July 1960, p. 283. Mr. Clague is Commissioner of Labor Statistics, United States Department of Labor.

2/ Ibid.

The specifications for the goods and services priced are carefully defined and in detail. As a result, there is the possibility that prices of commodities that are "out of style" may be used to reflect the changes of prices of a group of similar items that are in general use.3/

3/ Government Price Statistics. pp. 32-34.

The prices are usually actual exchange prices. Whether the prices are representative is open to question since the time and place of price sampling is affected by practical considerations. For example, the Food-at-Home Index, a sub-index of the Consumer Price Index, does not include prices from transactions on weekends, or during sales lasting less than a week, because the respondents that supply price data will not take the time to work on a price list with the Bureau agent when their stores are crowded with customers.4/

4/ Ewan Clague, op. cit., p. 281.

There is also the question of whether a fixed market basket index is a realistic measure of the effect of price changes on consumers since purchases can be rearranged to avoid buying products whose prices have risen and equally desirable new low priced products can be substituted.5/

5/ Government Price Statistics. p. 51.

The quantity data used to weight the prices are those established through a survey conducted in 1950-51. The comprehensive revision of this index that is scheduled to go into effect in the January 1964 index will use weights based on a survey conducted in 1960-61.

The formula used in the construction of the Consumers Price Index is a fixed-weight formula that is weighted by quantities established by a survey and revised less often than once in ten years.

Any decision involving the use of the Consumer Price Index for making adjustments for price-level changes should give careful consideration to the effects of (a) the limited universe, (b) the complex sampling plan coupled with the inability to determine sampling errors, and (c) the qualifications imposed by a market basket that is weighted by quantities established by a survey.

The Wholesale Price Index -- The Wholesale Price Index is not, as implied by its title, an index of prices either paid to or received by wholesalers, distributors, or jobbers. It does not refer to "any definable set of producers or purchasers in the economy."[6/] Wholesale, as used in the title of this index, refers to sales in large lots at primary market levels, i.e., the first important commercial transaction for each commodity.[7/]

6/ Ibid., p. 64.

7/ Wholesale Price Index. Reprint of Chapter 10, from BLS Bulletin 1168. United States Department of Labor. p. 2.

The universe, as defined by the Bureau of Labor Statistics, is the total of primary-market transactions in the United States.

As currently compiled, the Wholesale Price Index covers agriculture, mining, and manufacturing. Construction materials are covered as a part of manufacturing, but construction itself is not included, nor is transportation.8/ Exports (up to the point at which they leave the domestic market) and imports are included in the index but they are not segregated.

8/ Government Price Statistics. p. 65.

Judgmental sampling is used to select the most important commodities in each field for inclusion in the Wholesale Price Index. Knowledge of each industry and its important products is derived through consultation with leading trade associations and manufacturers in each field and from Census data.9/

9/ Wholesale Price Index, op. cit., p. 4.

Commodity specifications were selected on advice from industry and other sources and are precisely defined as to both commodity characteristics and the terms of sale from specified types of sellers to specified types of purchasers.10/

10/ Ibid., p. 3.

In general, prices used represent seller's net realization per unit which is defined as actual sales less normal discounts, in approximately similar quantities to similar classes of buyers. Prices quoted on organized exchanges or markets are also used. List or nominal prices quoted in trade journals or by manufacturers are used when they satisfy the above criteria and reflect the industry's customary pricing practices.[11/] The consistent use

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11/ Ibid.

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of these prices normally will not distort the index (as previously explained on pages 44-45) since the index attempts to measure relative price movements and relationships among prices, not the absolute level of prices.

The quantity weights used are based on value of shipments data from industrial censuses, with interplant transfers excluded where possible. Each commodity priced is considered to be representative of a class of commodities and is assigned the weight of the whole class.

The prices, then, although not necessarily transaction prices, do reflect the industry's customary pricing practices and the quantity weights used are based on data from industrial censuses rather than the quantities actually exchanged in the periods being compared.

The formula used in the construction of this index is a fixed-weight formula that uses given year prices weighted by

quantities from an industrial census taken a few years previous to the given year, and 1957-59 base year prices weighted by the same census data. For example, the wholesale price index numbers for 1960 used weights from the 1954 Census of Manufacturers. In January 1961 new weights from the 1958 Census were introduced into the index for the first time.

For accounting purposes, the group indexes and individual price series that are components of the all-commodity index would be of most value in making adjustments to financial reports for changes in the specific prices. The absence of probability sampling to determine the commodities to be priced does not affect the reliability of the individual series.

When using wholesale price index numbers, consideration should be given to some limitations of this index that have been pointed out by the Bureau of Labor Statistics.

> Some limitations on the use of the wholesale price index have already been mentioned. The index is designed to measure change, not absolute levels of prices, and the quotations used in the index for individual commodities do not necessarily measure the average dollars-and-cents levels of prices. The index is not a true measure of the general purchasing power of the dollar -- it does not include prices at retail, prices for securities, real estate, services, construction, or transportation. Even at wholesale or primary market levels, the index, while a good approximation, is not a perfect measure -- since it is based on a relatively small sample of the many commodities which flow through these markets. In addition, there are some real price changes which the Bureau cannot measure -- for example, some improvements in quality, hidden discounts, differences in delivery schedules, etc.

The index has not been designed for use in measuring margins between primary markets and other distributive levels. Thus, direct comparisons of the wholesale and consumer price indexes cannot be used to estimate or evaluate margins. The index does not measure prices paid by industrial consumers since it normally excludes transportation costs and similar factors affecting final prices. Finally, the index should not be used to forecast movements of the Consumer Price Index, particularly over the short run. Many components of the wholesale price index never enter retail markets (for example, machinery); similarly, many components of the Consumer Price Index (such as services and rents) are not covered by the wholesale price index.12/

12/ Wholesale Price Index, op. cit., p. 11.

The Composite Construction Cost Index.--The U. S. Department of Commerce - Composite Construction Cost Index is the most comprehensive index available in the construction field. The universe of this index is the total cost of work put in place on all structures and facilities under construction during a given period. Estimates of this total cost are based on contract awards, building permits, progress reports on Federal construction projects, and financial reports. The estimates are then adjusted for seasonal variation and deflated to 1957-59 dollars by many indexes, most of which are privately compiled.

The sample is not a probability sample, nor can it properly be called a judgmental sample because the Construction Statistics Office (of the Department of Commerce, Bureau of the Census) that compiles this index has very little detailed information concerning the sources of data or the methods

used in the construction of the component indexes. In addition none of the component indexes, with the exception of the Bureau of Public Roads Composite Mile Index, is completely representative of any one specific primary classification of construction.[13/]

13/ Government Price Statistics. op. cit., p. 91.

Since this is primarily an input index, few of the component indexes make allowance for productivity changes. Therefore, attempts to use this index to measure price movements of the output of the construction industry are hampered by an upward bias to the extent that productivity has increased over time.

Until very recently the Construction Statistics Office did not collect any original data for this index. Some of the indexes used to deflate the current dollar estimates of construction costs are indexes of fixed quantities of material and labor which were typical of facilities constructed twenty-five to thirty years ago but are no longer representative, and at least one index excludes building fixtures (e.g., plumbing, heating, elevators) which are important items of construction cost.[14/]

14/ Ibid.

To the extent that the relative importance of the component construction costs have shifted since the base year, the composite index is biased in an unknown direction which either aggravates or counteracts the upward bias resulting from productivity change.

Because of the unknown effect of the weighting schemes included in the indexes used as deflators, the formula used in this index cannot be classified according to the schemes given in the previous chapter (pp. 46-47). It resembles the Paasche formula most closely because its construction begins with current dollar estimates of construction costs which includes current quantity data at current prices.

Of the four indexes reviewed in this report, the Composite Construction Cost Index currently displays the least cause for confidence based on procedures of its construction. In spite of its method of construction, however, there is reason to believe that the resulting index may be fairly accurate. In an article in the December 1961 American Economic Review, R. A. Gordon[15/] marshals considerable support for the validity of the constant dollar figures for that segment of Gross National Product that is deflated by the Composite Construction Cost Index. Evidence supporting this contention include:

> 1. One study...found that a specially constructed index of actual house prices rose by about the same amount as a residential construction-cost index over the period 1890-1934.
> 2. A completely independent study by Colean and Newcomb...found that the Engineering News-Record fixed-weight index of building costs rose no more during the period 1913-51 than an average of the indices of actual building costs compiled by four construction firms.

15/ "Differential Changes in the Prices of Consumers' and Capital Goods," pp. 937-57.

3. Prices of building materials, particularly lumber, have risen significantly more than the index of all wholesale prices, and it is unlikely that all of this differential increase in prices has been offset by savings in the use of materials.

4. There is good reason to believe that, over the last half century or more, the recorded rise in union wage rates in the building trades -- the wage component in most fixed-weight construction-cost indices -- does not seriously exaggerate the rise in unit labor costs, except in heavy engineering projects. Labor productivity in building construction has apparently risen relatively slowly over most of the period covered by our figures, and the trend in union wage rates understates the rise in actual hourly earnings.

5. Improvements in productivity have been retarded by union restrictions and building regulations. Also, some "external diseconomies" have been at work. Thus one factor in the rise in building costs has been "the rapidly increasing complexity of the urban environment resulting from greater concentration of population on the one hand and higher standards of health and safety on the other". . . . .

6. Where extensive mechanization has been introduced, some of the resulting labor saving has been offset by an increase in cost per unit of output for such items as interest, depreciation, fuel and power, etc. . . . .

7. Raymond Powell . . .after a careful survey of the evidence for the United States (largely from the same sources that we have cited), reaches the following conclusion:

. . .there has been little divergence in the trends of input and output prices in residential and non-residential building construction in the U.S. over the periods covered. . . .

. . .building construction in which the trends of input and output prices appear to have been similar, account for the greater part of total construction 16/

16/ Ibid., pp. 943-44.

A comprehensive program for the improvement of construction statistics is in process by the Bureau of the Census. The program is based on the recommendations of the Price Statistics Review Committee17/ and is seeking to eliminate the shortcomings

17/ Government Price Statistics, Appendix B.

of present construction statistics. The general objectives of the Bureau include (1) the measurement of prices rather than costs (i.e., the prices of the output of the construction industry instead of the costs of its inputs), (2) the use of actual transaction prices rather than estimates, and (3) methods of measurement that apply to the entire field of construction (e.g., pricing separate operations for types of construction that do not lend themselves to handling as complete projects).[18/] Since the Bureau is

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18/ Samuel J. Dennis, Recent Progress in Measuring Construction, U. S. Department of Commerce, Bureau of the Census, Washington, 1962. Mr. Dennis is Chief of the Construction Statistics Division of the Bureau of the Census.

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pioneering in construction price indexes, it faces problems not previously explored. The improvement in construction statistics that ensue from this program will also result in the improvement of our national income accounts and the GNP deflator.

GNP (Gross National Product) Implicit Price Deflator--The most comprehensive price index available is an outgrowth of national income and product accounting which is one of the chief tools for formulation of Government economic policy. This index,

the GNP (Gross National Product) Implicit Price Deflator, is implicit in the relationship between the current and constant dollar estimates of Gross National Product. The report of the National Accounts Review Committee, National Bureau of Economic Research to the Subcommittee on Economic Statistics in 1957 termed the estimates "as good as the primary data and funds available for their processing and analysis permit."[19/] Improvements have since been made based on some of the recommendations in that report.

19/ Hearings before the Subcommittee on Economic Statistics...October 29 and 30, 1957, The National Economic Accounts of the United States, p. 110.

The universe for this index encompasses all exchange transactions in the economy that affect the general level of prices. It is the only index presently compiled that reflects an average of all goods and services exchanged in all segments of the economy. It is an index of the prices of final products, consumer purchases, and business investment. The national economic accounts from which this index is constructed "constitute a systematic record of basic information about economic activity....[20/]

20/ Ibid., p. 133.

The data used in estimating and deflating Gross National Product are collected by various governmental and private agencies for other purposes as a by-product of administrative routine. As a result these data must be further processed to

adjust them to use for this purpose. Reliance must be placed on judgment and the development of benchmarks derived from alternative measurements. As a result, quantitative indicators of the degree of statistical precision are not available.[21/]

21/ Ibid., pp. 217-18.

The U. S. Department of Commerce, Office of Business Economics prepares the GNP Deflators but it neither collects the data itself nor controls their collection. Therefore the sample cannot be accurately described as a judgmental sample, even though judgment must be exercised by the Office of Business Economics in the selection and processing of data supplied by other agencies.

The sub-indexes of the Consumer Price Index, the Wholesale Price Index, the Composite Construction Cost Index, and other indexes compiled by various governmental agencies as well as other price lists and catalogs are used to deflate the portions of Gross National Product to which they apply. Improvements in the individual indexes used as deflators result in improved GNP Implicit Price Deflators.

One of the areas most in need of improvement is in the construction statistics. Accurate measurement is difficult in this area because of the number of small-business units, many of which do not maintain adequate records, and the diversity of the products. Each construction project usually has unique characteristics which complicate the collection of comparable data.

A considerable start has been made in the last few years toward accurate construction data; there are, however, still many problems to be solved.

The formula used for the GNP deflator is a Paasche type formula; however, various formulas are used in the computation of the sub-indexes. It is the only one of the output price indexes reviewed in this study that is based on current weights that change every year.

The importance of the Gross National Product estimates (in both current and constant dollars) in the formulation of economic policy gives continuing impetus to their improvement. As the estimates become more accurate, the index inherent in the relationship of the estimates before and after deflation improves accordingly. The over-all estimates are probably more reliable than the various segments because the best check now available for the estimation of Gross National Product is the reconciliation of the aggregate with the total derived in estimating National Income, which has attained a high degree of reliability for the period since 1939. The major portion (by far) of National Income is compensation of employees. Estimates of total wages and salaries are reliable because they are based on data from the Railroad Retirement Board and the Social Security Administration.

The reporting systems under the Railroad Retirement and Social Security Acts approach the ideal as a source for income estimates.[22]

[22] National Income, 1954 Supplement to the Survey of Current Business, United States Department of Commerce, Office of Business Economics. p. 68.

Federal Income Tax information also supplies benchmarks for checking the accuracy of components of National Income and Gross National Product.

The GNP Implicit Price Deflator is the only index currently compiled which measures the over-all or general level of prices. It is a "good" index but the method of sampling and the absence of control over data collection by the Office of Business Economics preclude giving a numerical value to its statistical precision.

The Best Currently Available Index or Indexes for Recasting Financial Reports

Index of the general level of prices -- Money is the common denominator in which financial data presented in accounting reports are measured.[23] The purchasing power of the dollar, however, varies from time to time, and as a result, assets, liabilities, revenues, and expenses are expressed in "dollars" which represent different purchasing powers.[24] If financial

[23] Maurice Moonitz, "The Basic Postulates of Accounting," Accounting Research Study No. 1, (American Institute of Certified Public Accountants, 1961), p. 22, Postulate A-5.

[24] Ibid., pp. 44-46.

statements in dollars that have the same purchasing power as "dollars in general" are desired, an index of the general level of prices is needed, because the dollar is a commodity whose value (purchasing power) varies in inverse proportion with the general level of prices of the commodities for which it can be exchanged. When the general level of prices rises, the value of the dollar falls because more dollars are needed to buy the same quantity of commodities. Conversely, when the general level of prices falls, the value of the dollar rises because fewer dollars are needed to purchase that quantity of commodities.

The only index currently compiled that is a measure of the general level of prices in the United States is the GNP Implicit Price Deflator. It is the only price index compiled in this country whose "universe" encompasses the entire economy.

There has been a high degree of correlation between price movements measured by the GNP Implicit Price Deflator and the Consumer Price Index. There is, however, no guarantee that this relationship will continue because the Consumer Price Index does not attempt to measure price movements for the economy as a whole.

Deflators by calendar quarters are available only since the first quarter of 1947; annual deflators are available for every year back to 1929. However, since the precision of the measure of change is open to serious question when the goods and services available in the two periods being compared are dissimilar, and because so many of the goods and services currently available

resulted from wartime (World War II) and postwar technology, it would probably be desirable to select a cutoff date instead of using prewar or even wartime index numbers for the adjustment of the applicable data in financial statements.

The data from which the deflators are computed are provisional when first published and revised as additional information becomes available. The final revised data together with the deflators are published annually in July for the previous year. In recent years, the differences between deflators computed from the provisional data and the final published deflators have been minor. When considered in relation to their use for adjustment of financial data, the effect would be immaterial. As a result of our investigation we are convinced that the GNP Implicit Price Deflators are reliable enough for accounting purposes.

Changes in the prices of specific commodities -- Changes in the prices of specific commodities can be reflected in financial reports by the use of appropriate price series for the individual accounts that appear in those reports. Fortunately, as indicated in Chapter 2, a wealth of price data is collected and published by various agencies of the Federal Government. Some of these prices have been converted into indexes, others have not. The non-indexed price series are easily converted into indexes by the formula $\frac{p_1}{p_o} \times 100$ [i.e., divide (i) the price for each successive date, p_1, by (ii) the price for the date selected as the base, p_o, then multiply by 100]. The sub-indexes of the Wholesale Price Index would supply many of the needed indexes.

The most troublesome area would be finding good indexes to adjust building values, due to the inadequacies in construction cost indexes currently compiled; however, the solution is in process.

Price-level changes for limited segments of the economy --

Indexes to adjust for price-level changes affecting limited segments of the economy that would also be appropriate for recasting of financial statements are not available. The over-all Wholesale Price Index does not refer to any definable set of producers or purchasers in the economy. An "Index of Change in Prices of Goods and Services Purchased by City Wage-Earner and Clerical-Worker Families to Maintain Their Level of Living" /emphasis supplied/ does not seem to have any qualifications that would make it theoretically appropriate. An index of "Gross Private Domestic Investment," a sub-division of Gross National Product, would seem to be appropriate but it is not reliable. The Office of Business Economics does not compute a separate deflator for this sub-division because a significant component, change in business inventories, includes elements of opposite algebraic sign (see pages 22 and 23). An index constructed from two sub-divisions of Gross Private Domestic Investment, i.e., other new construction and producers durable equipment, would have two major deficiencies: (1) it would not include all types of purchases in any segment of the economy and (2) data on new construction, the largest segment, has serious limitations at the present time.

Recommendations for Improvement

One of the major limitations on the construction of adequate indexes in the United States is the shortage of funds made available for this purpose. Committees organized by the National Bureau of Economic Research have made studies of government price statistics and national economic accounts. Reports of these studies together with recommendations for improvements have been made to the Subcommittee on Economic Statistics of the Joint Economic Committee of the Congress of the United States. Some of the recommendations have been put into effect but insufficient funds preclude the adoption of many of them at the present time. If the business community wants better data than are currently available, it will have to encourage the allocation of sufficient funds for their compilation. In order to obtain improved indexes for restating financial statements, funds should be allocated to the study of and research into the problems of sampling methods, of gathering basic data, and of the timing of revisions of weights, as well as to a program of publication of changes and improvements. Research into methods of measuring price changes should encompass underlying statistical theory and techniques.

Government price statistics and national economic accounts are the basis of policy decisions by business, labor, individuals and government. A wealth of statistics are collected and published by numerous governmental agencies on a wide variety of topics. Their importance for economic and business analysis continues to grow. The improvement of economic statistics would benefit both their users and all who are affected by the policies dependent in part on their use.

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